ELECTRICALLY TRIGGERED DROP NET TO CAPTURE WILD SHEEP

Ministry of
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Williams Lake, B.C.

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John W. Hirsch

Supervisor: John Youds

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INTRODUCTION

One of the most renowned herds of California bighorn sheep (Ovis canadensis california) is the Junction herd. Many of the sheep have been captured, tagged and released or relocated to other formerly inhabited ranges within British Columbia and the northwestern United States.

To date, three methods have been used to capture bighorn sheep: drive netting, net gunning and drop netting.

Drive netting involves the setting of net panels, one behind another in a semi-circle. A helicopter then drives the sheep into the nets, whereupon bystanders pin the sheep to the ground. They are then drugged, blindfolded and hobbled.

Net gunning also uses a helicopter. The helicopter must get as close as possible to a sheep, then a net gun (a rifle like apparatus) is used to launch a net over the sheep. The helicopter then lands next to the entangled sheep, whereby it is quickly drugged, blindfolded and hobbled.

Drop netting requires a large net 22.9 m x 22.9 m (75 ft. x 75 ft.) suspended 3 m (10 ft.) above the ground by five poles. The sheep are attracted under this net with bait, such as apple mash. Blasting caps are then used to break the ropes, releasing the net on top of the sheep.

Drop netting is the preferred and generally the most economic method for capturing sheep on the Junction. Drop netting, however, can be more time consuming than the other methods; not only does the net have to be set up, but it must be monitored frequently for sheep use. Once sheep use under the net is consistent, someone with a blasters ticket must go out before the actual trapping to wire the net with blasting caps. The blaster then has to stay at or near the site until the caps have been detonated. This means that the blaster must be available on short notice and be able to stay onsite for at least 2 days.

To alleviate the current problems associated with drop netting, an electrical system to release the net was investigated. An electrically released system would mean that sheep use would not have to be monitored as frequently and a blaster would not be required. This would save considerable staff time as well as increasing the number of opportunities when the net could be dropped.

Emmerich et al. (1982) developed an electrically released system consisting of five cargo hooks, a six piece wire harness, a 24-volt power source/trigger mechanism and a manual push button release switch or an optional remote control release switch to capture wild sheep, whereas Johnson and Moorehead (1982) used a simple pull-pin manual release or, if necessary, blasting caps to capture wild goats.

I would like to thank the following people for their support:

T. Arduini of Okanagan Helicopters for the loan and wiring of four helicopter cargo hooks.

J. Hirsch, Sr. for building and donating a fifth release mechanism, as well as assisting on electrical aspects of the project.

G. Pope and Columneetza Senior Secondary for donating the heavy duty machine starting solenoid.

B. Chapman and H. Langin for advice on electrical aspects of the project.

J. Youds for advice and technical support.

S. Schlitt for typing the first draft.

B. Strohschein for typing the second draft.

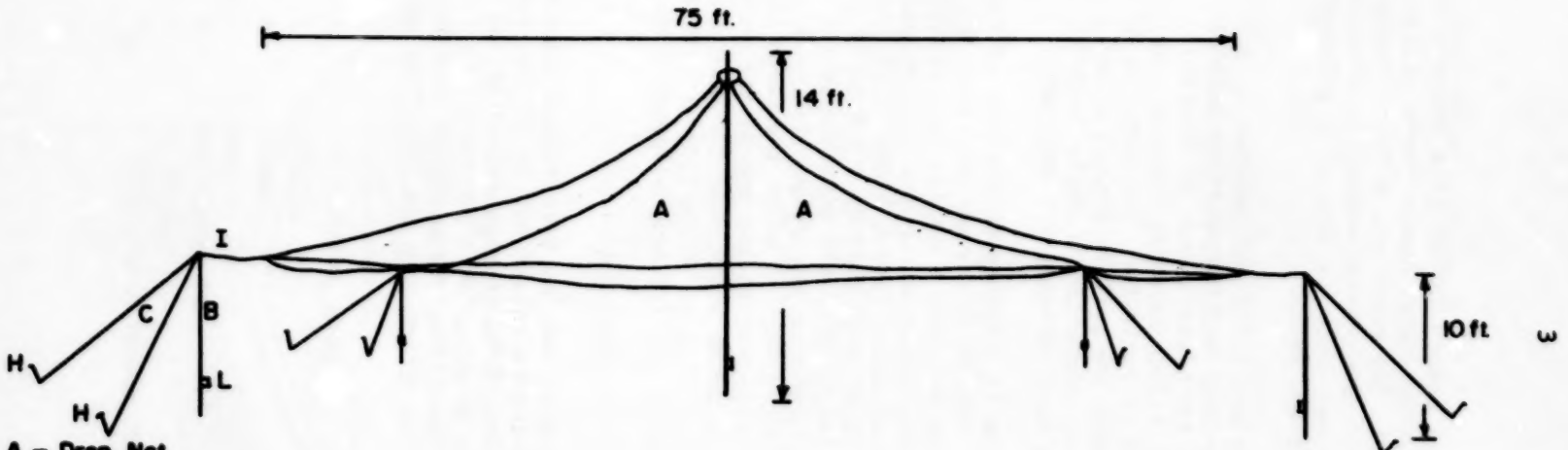
B. Matthews for typing the final draft of this report.

METHODS

DROP NET

A 22.9 m x 22.9 m (75 ft. x 75 ft.) nylon net with meshes 5 cm x 5 cm (2 in. x 2 in.) is suspended 3 m (10 ft.) above the ground by five metal poles. The net has a metal ring in each corner for easy draw and release rope attachment. The net also has a 0.61 m (2 ft.) hole in the centre, allowing for easy movement up and down the centre pole. On each side of the hole , a 0.3 m (1 ft.) length of rope attaches to a snap hook, that is used for the attachment of the centre draw and release ropes.

The poles are made of 3.8 cm (1 1/2 in.) outside diameter pipe, with the corner poles being 3 m (10 ft.) and the centre 4.2 m (14 ft.) in length. To each pole a hand crank boat winch has been welded. The winch is used to raise the net. A draw rope runs from the winch through a pulley at the top of the pole to the net. The poles are supported in two ways: a 0.92 m (3 ft.) piece of reinforcing bar (rebar) driven into the ground that the pole is slid over and two metal guy cables, which run from the top of the pole to the ground where they are anchored by 0.92 m fence poles (the angle between the cables is 30^{o} to 45^{o})(Figure 1). This is larger than the system used by Johnson and Moorhead (1982) and similar to the system used by Emmerich et al. (1982), except that Emmerich et al. (1982) use a guy wire superstructure between poles, the corner poles are 3.8 m (12 ft.) and the centre pole is 6.1 m (20 ft.) with an outside diameter of 6.4 cm (2 3/8 in.).



A – Drop Net

B - Support Poles (1-5) with electrical hooks (M 1-5)

C - Metal Support Cables

H - 3ft. Metal Fence Post

I - Release & Draw Ropes

L -Boat Winch

Figure 1 DROP NET

RELEASE MECHANISMS

The release mechanism is comprised of five electronically activated hooks, four of which are helicopter cargo hooks (three styles)(loaned by T. Arduini of Okanagan Helicopters). The hooks use a four wire system, but only two wires are needed to activate the release mechanism (Pins A and C). The hooks need a 24 V power source, such as two 12 V automotive batteries connected in series (Emmerich et al. 1982).

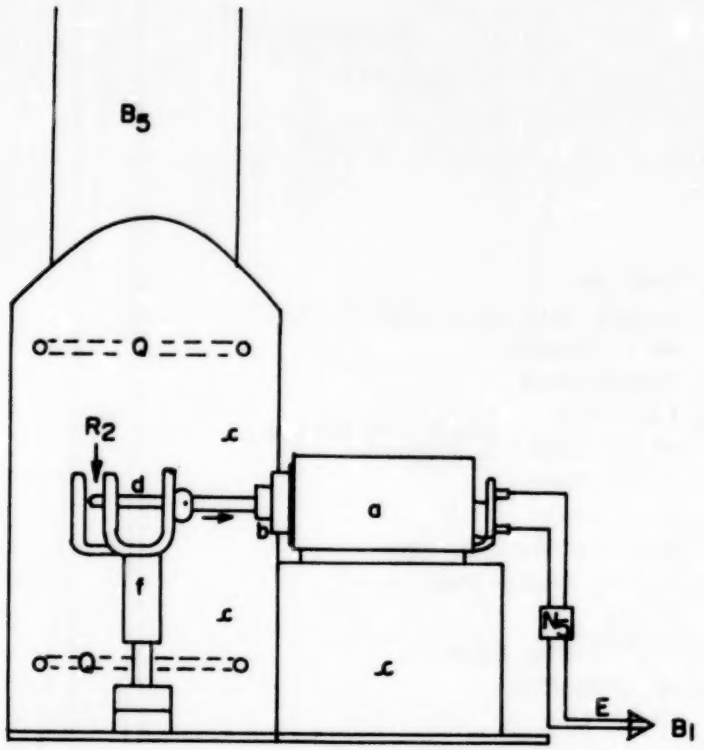
A fifth release mechanism was built and donated by a local hunter, J. Hirsch, Sr., which uses a heavy duty machine starting solenoid (HDMSS)(Figure 2). The HDMSS consists of a coil and a set of contacts: the coil when energized creates an electrical field, becoming a magnet, which then draws in a plunger that picks up the set of contacts. The HDMSS (a 12 V system (Part #SS-42)) was modified so that when the coil is energized and draws the plunger in, instead of making the set of contacts, it pulls in a pin that holds the release rope in place, which in turn releases the drop net.

The HDMSS release mechanism is attached to the base of Pole 5 by two 3.8 cm (1 1/2 in.) muffler clamps. The release rope goes from the holding pin of the HDMSS to the top of the pole, over a pulley and connects to the net (Figure 3). The cargo hooks are attached to the corner poles by muffler clamps, quick links and lengths of chain (seven links long). A 1 cm (3/8 in.) quick link is anchored to the top of each pole by a 3.8 cm (1 1/2 in.) muffler clamp. Each cargo hook has a length of chain attached to the top and bottom. The centre link of the chain clips into the quick link. This is similar to the system used by Emmerich et al. (1982) in which the cargo hook is suspended by a carabiner (quick link) attached to the top of the pole. The release ropes for the cargo hooks are modified motorcycle tie-down straps (the hooks on the straps being replaced with 1 cm quick links), with a 10 cm (4 in.) metal ring on the hook side that allows for easy slippage (Figure 4).

WIRE HARNESS

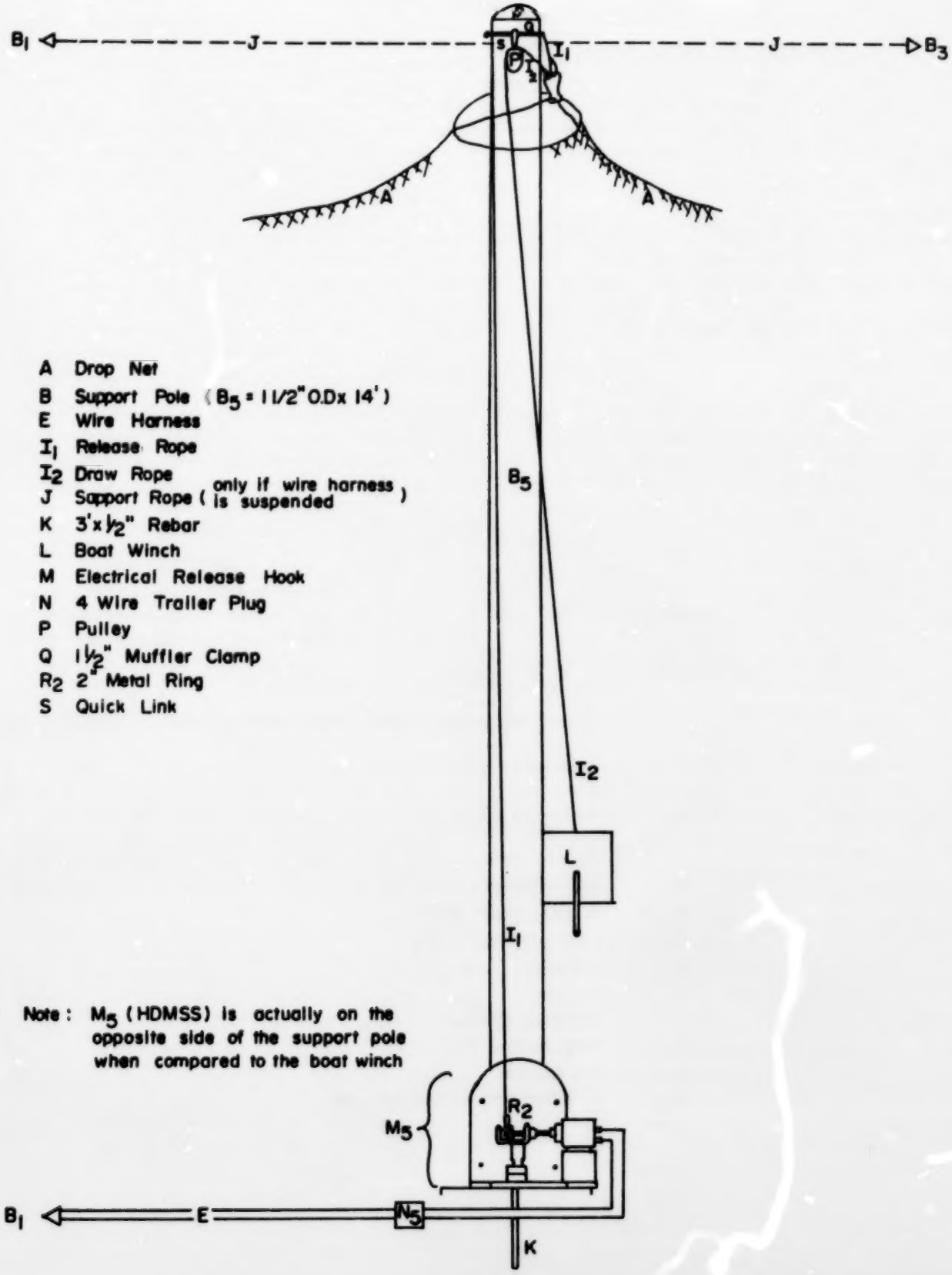
While devising a wire harness for the five release mechanisms, we found that the 12 V HDMSS release mechanism could not be on the same feed line as one of the 24 V cargo hooks. The HDMSS release mechanism has less resistance than the 24 V system thereby drawing more current. As long as the HDMSS release mechanism has its own feed line, there was no problem. If a problem does develop, a resistor would be attached to the feed line before the HDMSS.

CENTER RELEASE HOOK, Figure 2



SYMBOLS

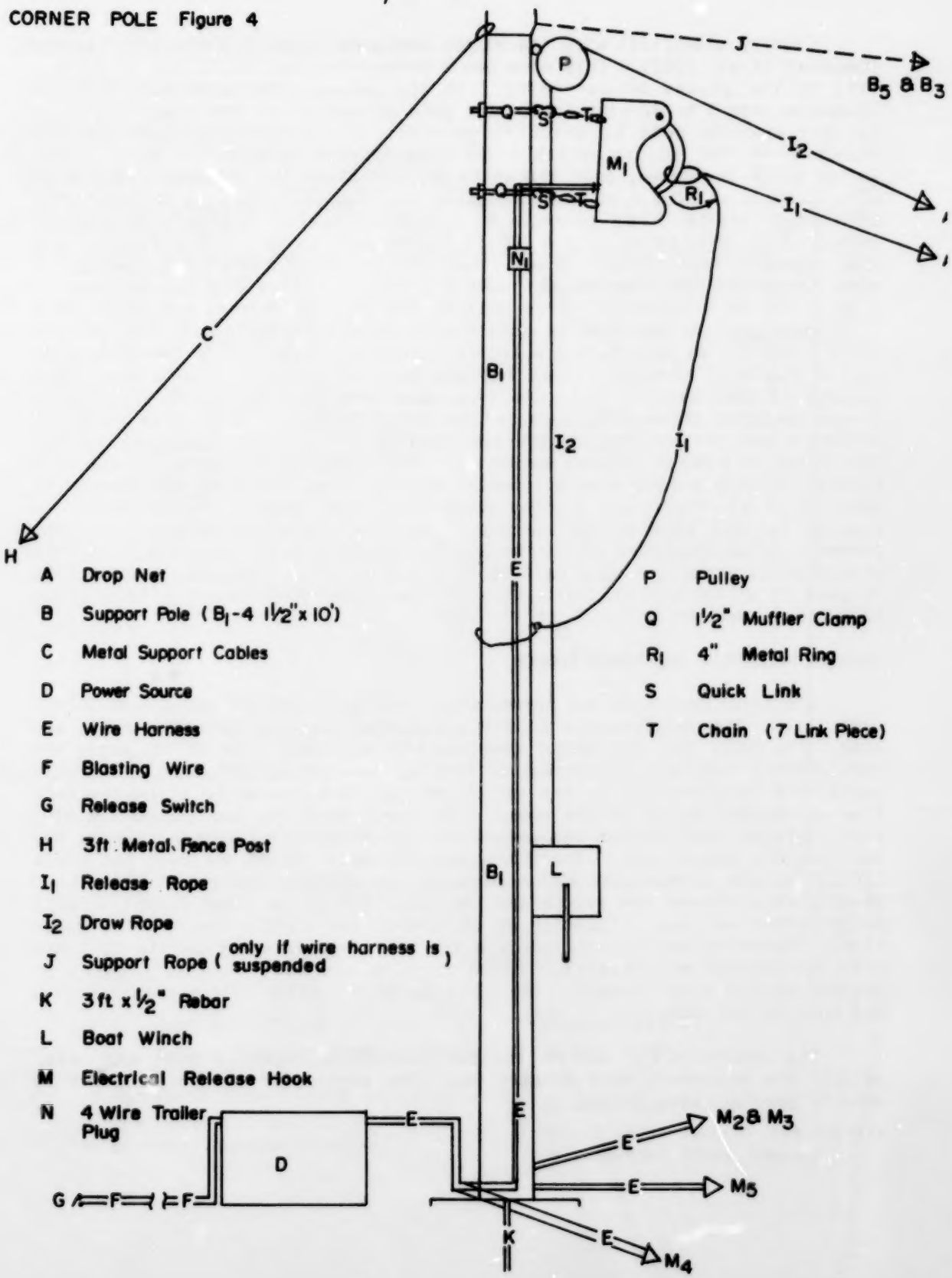
B	Support pole
E	Wire Harness
N	4 wire trailer plug
Q	1 1/2" Muffler clamp
a	HDMSS
b	Plunger
c	Mounting Bracket
d	Ring holding Pin
f	Pin Bracket
R_2	2" Metal ring of release rope



A Drop Net
B Support Pole (B_5 = 11/2" O.D x 14')
E Wire Harness
I_1 Release Rope
I_2 Draw Rope
J Support Rope (only if wire harness is suspended)
K 3' x 1/2" Rebar
L Boat Winch
M Electrical Release Hook
N 4 Wire Trailer Plug
P Pulley
Q 1 1/2" Muffler Clamp
R_2 2" Metal Ring
S Quick Link

Note : M_5 (HDMSS) is actually on the opposite side of the support pole when compared to the boat winch

CORNER POLE Figure 4



A Drop Net
B Support Pole (B_1-4 1½"x 10')
C Metal Support Cables
D Power Source
E Wire Harness
F Blasting Wire
G Release Switch
H 3ft. Metal Fence Post
I_1 Release Rope
I_2 Draw Rope
J Support Rope (only if wire harness is suspended)
K 3 ft x ½" Rebar
L Boat Winch
M Electrical Release Hook
N 4 Wire Trailer Plug

P Pulley
Q 1½" Muffler Clamp
R_1 4" Metal Ring
S Quick Link
T Chain (7 Link Piece)

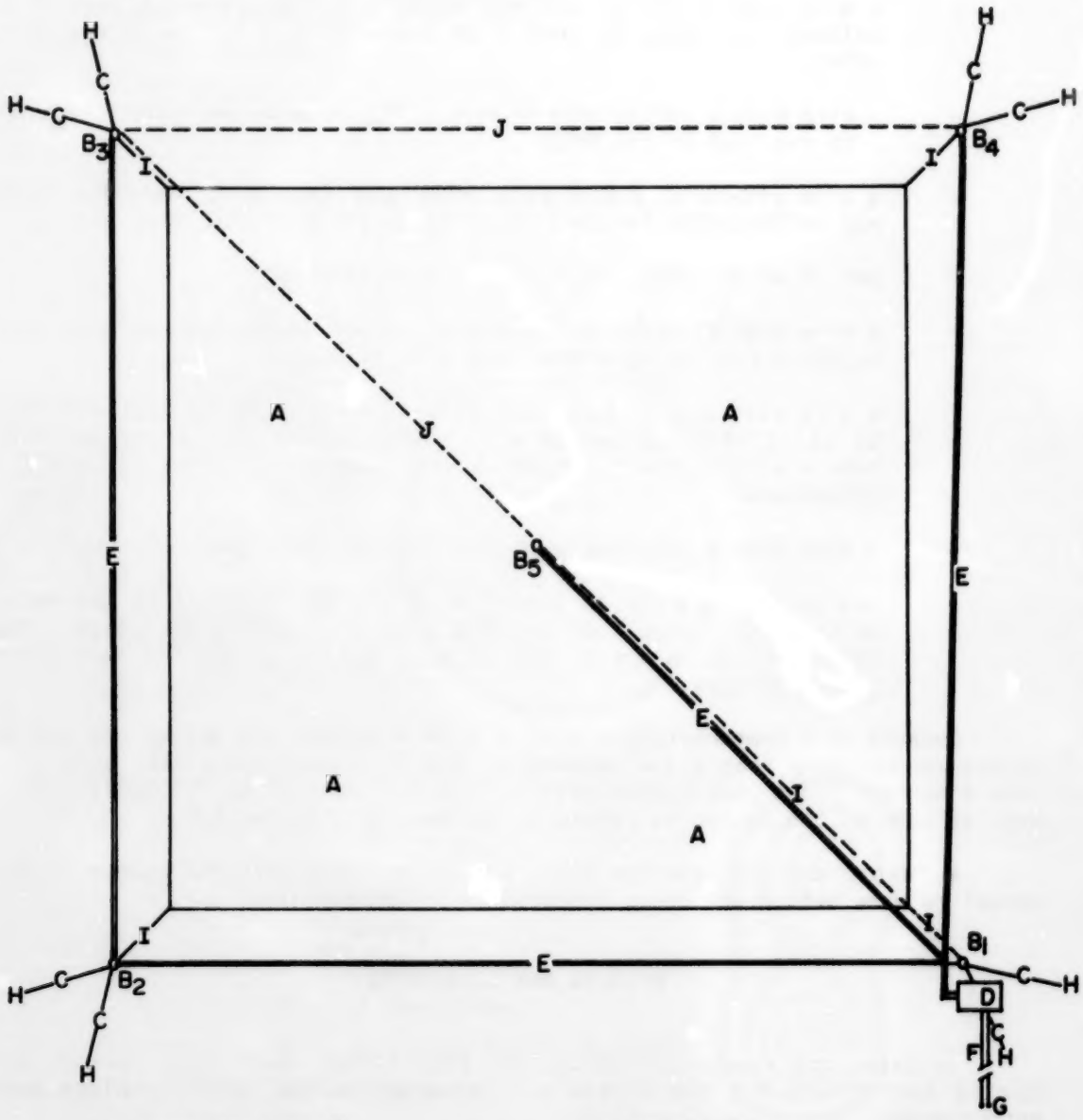
Cabtire electrical wire (14 gauge) was used to make up the wire harness (Emmerich et al. 1982). This wire has a protective coat so it can be buried, laid on the ground or suspended from the poles. The poles were numbered clockwise from 1 to 4, with the centre pole as number 5. THe power source is located next to pole 1, which is generally the corner pole closest to the direction of the release switch. The wire harness consists of three wires: white, black and green; only the white (+) and black (-) are used. The white wire connects to post 4 of the automotive starting solenoid by a yellow circle wire crimp, and the black connects to a negative post by a blue fork terminal crimp. From this point, a 3 m (10 ft.) wire goes to pole 1 and divides into four separate feed lines. These lines are connected together by two No. 2 wire connectors and then taped. One 3 m (10 ft.) line goes to the hook on pole 1, one 20 m (65.6 ft.) line goes to the hook on pole 5, one 27 m (88.6 ft.) line goes to the hook on pole 4 and one 55 m (180.4 ft.) line goes to poles 2 and 3. At pole 2, a 3 m (10 ft.) piece is spliced into the line using yellow insulated terminal crimps for the hook on pole 2 (Figure 5). This harness is considerably different from that used by Emmerich et al. (1982). It was designed differently because the cargo hooks in this case were all different and did not require the same current and also to compensate for the use of the 12 V HDMSS release mechanism. The hooks are connected to the wire harness through a four wire automotive trailer plug, for easy disconnection; Emmerich et al. (1982) use a three prong twist-lock socket. Two wires of the plug go to each wire in the harness. The plug wires and harness wires are joined by blue insulated wire crimps. The female side of the plug is on the wire harness side, the male half is on the hook side. Wherever a wire crimp is used to splice a line, the splice is then taped with black electricians tape for protection.

TRIGGER MECHANISM AND POWER SOURCE

A trigger mechanism was needed that could activate the hooks from 300+ m (984 ft.). For this reason, a 12 V automotive starting solenoid (AMSS) was used. The AMSS, like the HDMSS, consists of a coil and a set of contacts; the coil needs a few amps of current to pick up the set of contacts. The coil would then be energized by the switch and the contacts would allow the main flow of current to go to the hooks. We hoped that the two strand blasting wire could be used between the switch and the AMSS. This wire , however, was too fine (24 gauge) and , therefore, had too much resistance over the 600 m (300 m to the switch and 300 m back to the AMSS). Instead of going to a heavier wire between the switch and the AMSS (18 gauge lamp cord), a 12 V relay switch was used. Emmerich et al. (1982) use a 183 m length of 12 gauge wire. The relay switch only needs a few milliamps to energize its coil and pick up its set of contacts. Blasting wire was more than sufficient to deliver this sort of current. The contacts in the relay switch then energize the coil in the AMSS.

The entire power source (batteries, AMSS, negative post and relay switch) are encased in an insulated box. The wiring for the power source is done in the following manner:

DROP NET & ELECTRICAL WIRE HARNESS: Figure 5



A - Drop Net (75 ft.^{2})

B - Support Poles (1 - 5) with electrical hooks (M1-5)

C - Metal Support Cables

D - Power Source

E - Wire Harness (Cabtire)

F - Blasting Wire

G - Release Switch

H - 3 ft. Metal Fence Post

I - Release Rope & Draw Rope

J - Support Rope (only if wire harness is suspended above ground)

- a wire with a battery terminal clamp (BTC) on each end goes from the + post on one battery to the - of the other.

- a wire with a BTC on one end connects to the unused + post of a battery and goes to post 1 of the AMSS by a yellow circle wire crimp.

- a wire with a yellow circle wire crimp on each end goes from post 1 to the base of the AMSS.

- a wire with a blue fork wire crimp goes from post 2 and the other end using a blue female wire crimp to pin 5 of the relay switch.

- post 4 of the AMSS goes into the wire harness.

- a wire with BTC from the remaining - post of the battery goes to a negative post using a blue fork wire crimp.

- a wire with a blue fork wire crimp from a negative post attaches to pin 1 of relay switch with a blue female wire crimp and from here a wire to pin 2. Again a blue female wire crimp is used for attachment.

- a wire from a negative post goes into the wire harness.

- the blasting wire is attached at one end to pin 4 of the relay switch and to post 1 of the AMSS with red female wire crimps. The other end attaches to the release switch using red fork wire crimps (Figure 6).

Because 12 V components are used in a 24 V system, the switch can not be turned on for more than a few seconds or the 12 V components will burn out. Thus a spring-loaded push button switch is used (Emmerich et al. 1982). This way, as soon as the button is released, the switch is turned off.

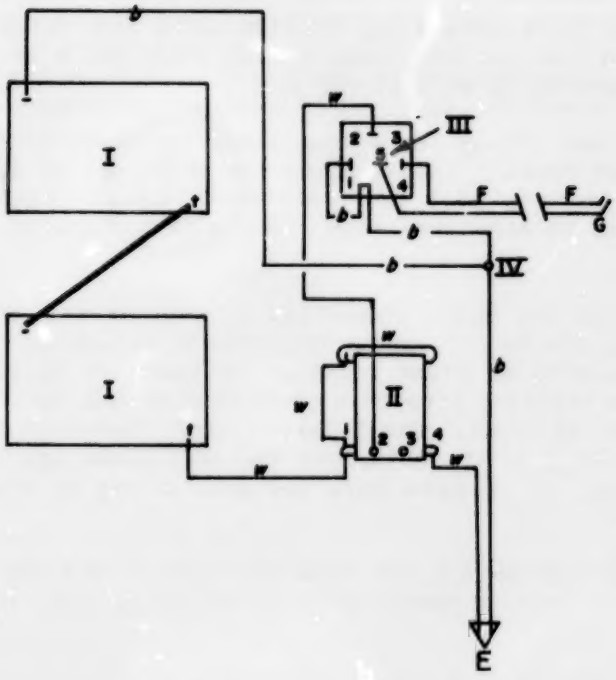
A remote control device could be incorporated into the system if the manual release switch was found troublesome or inconvenient.

RESULTS AND DISCUSSION

To date, the electronic system has been tested under fall, winter and spring conditions and has worked well although several minor problems were encountered:

- As the cargo hooks are mounted approximately 30 cm (12 in.) below the top of the pole, added tension is needed so that net sag does not hinder access. This results in a lot of net spring when released. To compensate for this, an additional 3-m length of rope was attached from the net corner to the base of the pole.

POWER SOURCE , Figure 6



SYMBOLS

E	Wiring Harness
F	Blasting Wire
G	Release Switch
I	12 Volt Battery
II	Automotive Starting Solenoid
III	Relay Switch
IV	Negative Post
w	(+) wire (White)
b	(-) wire (Black)

- To prevent rust and ice formation on the hooks, various lubing compounds were tried. WD-40 was found to be the best as it prevents rust while acting as a lubricant and it does not congeal at colder temperatures (-10°C and colder).

  Secondly, to help protect the release mechanisms from the elements, they should be wrapped with an insulating material (rags or fibreglass) and covered with a plastic or waterproof hood.

- Due to an initial wiring problem with the relay switch, the release switch has only been tested with 350 m of blasting wire but is expected to work at 600 m.

If the net has been set up for a long time, the hooks should be tested. Simply unplug any four hooks. Then tighten the draw rope on the pole of the hook to be tested so the net will not completely drop. Push the release switch, reset hook and release draw rope. Try another hook or plug the rest back in.

If the hook does not open, check the wiring of the AMSS and relay switch. If the wiring checks out, press the release switch and listen for the AMSS picking up (a buzzing or clunk sound). If there is no sound, there is either a break in the blasting wire or a problem with the relay switch. The relay switch is easier to check, simply take a short length of wire and touch it across pin 4 and post 1 of the AMSS. If the AMSS picks up, the problem is in the blasting wire; if it does not, the problem may be within the relay switch.

Should the AMSS pick up but the hook not open, check the hook for any ice on the release and locking mechanism. If there is ice, check the other hooks as well.

If the cargo hooks start to open and then stop, they have to be reset before they will re=open. To reset them, just push on the release and locking mechanism or the swing arm; a click should be heard.

As the cargo hooks are anchored 0.3 m (1 ft.) below the top of the poles. the poles need to be as straight as possible. If the poles lean toward or away from the net, when the release rope is tightened, precious height is lost. Another way to alleviate this height problem is to lengthen the poles by 0.6 m (2 ft.).

The HDMSS release mechanism is by far the cheapest way to convert the net over to an electrical release system (approximately $1100 vs. $13 100). The centre HDMSS mounting bracket should remain as is or similar so the release rope can be tightened easier. The corner HDMSS release mechanisms should have a slightly different mounting bracket, should be attached to the top of the pole through the base of the mounting bracket and should be parallel to the pole with the ring holding pin on the bottom side.

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APPENDIX A. Procedure for setting up and wiring net.

1. Unroll net.

2. Approximately 2.4 m (8 ft.) from each corner, on the diagonal line, drive a 0.9 m (3 ft.) piece of rebar 1/2 to 2/3 into the ground. Attach the metal cables to the top of a corner pole and slide pole over rebar. Anchor cables to the ground by driving a 1 m metal fence post , at angle away from the pole, into the ground. Before anchoring cables, ensure that pole is as vertical as possible. Attach the winch draw rope to net and take up some slack. Follow the same procedure for the centre pole but without the cables. Make sure that the release rope is on the top pulley with snap hook on boat winch side of pole before standing pole upright.

3. Net is now ready to be raised. Raise the net as high as possible because there will be some slack and stretch in the release ropes upon taking the weight of the net.

4. Place the cargo hooks on the four corner poles. First, designate which pole is number 1, this pole should be closest to the direction in which the release switch will be going. The centre link of the chains snap into quick links attached to top of pole.

   As not all the cargo hooks are the same, the sequence of hooks are:

   green hooks - Poles 1 and 2
   yellow hooks - Pole 3
   gray hook - Pole 4
   HDMSS - Pole 5 (opposite side of pole to boat winch)

   A step ladder is needed to place the hooks on the pole and for connecting the release ropes.

5. Starting at pole 3, unroll the wire harness. All feed lines will have the female half of trailer plug at the end.

   Longest feed line - poles 2 and 3
   Next feed line - pole 4
   Next feed line - pole 5
   Shortest feed line- pole 1

   Connect the female half of plug on feed line to male half of plug on hook.

6. The power feed of the wire harness goes to the power source. The white wire goes onto the large unused post of the AMSS (post 4). The black goes to a negative post.

7. Attach wire with two battery clamps to (+) of one battery and (-) of the other. Attach wire with battery clamp, going from post 1 of AMSS to remaining (+) battery terminal. Attach wire with battery clamp going from a negative post to remaining (-) battery terminal.

8. The rest of the wiring for the AMSS and relay switch is already done, but should be checked. The sequence is as follows:

   - wire from (+) battery terminal to post 1 of AMSS
   - white wire from post 1 to base of AMSS
   - white wire from post 2 of AMSS to pin 3 of relay switch
   - red wire (should be replaced with black) from a negative post to pin 1 of relay switch
   - wire from pin 1 to pin 2 of relay switch

9. Take loose end of blasting wire and attach one strand to pin 4 of the relay switch and the second to post 1 of the AMSS. As this is for the release switch it does not matter which strand goes to which pin. Unroll wire in direction of where the switch is to be hidden. Slide 15 cm (6 in.) black plastic pipe over loose end and connect push button switch to wire. Slide pipe back over wire onto switch.

   NOTE: As the blasting wire is very fine, it should be suspended above the ground so it will not be stepped on or chewed.

10. Take corner release ropes and attach end with snap hook to net. Place 10 cm (4 in.) metal ring into release and locking mechanism of cargo hook and tighten rope as much as possible before tying off. Attach the remaining rope from the base of the pole to the corner of the net, which will prevent the net from springing inward too far when the hook is opened. For the HDMSS release mechanism, place the 5 cm (2 in.) metal ring into slot and slide ring holding pin into place. Thread release rope through ring, tighten and tie off. Ensure loose end of release rope cannot get tangled as this may prevent centre of net from completely dropping.

11. Slowly release tension in draw ropes.

12. Net is now ready to be dropped.

    NOTE: If the wire harness is to be suspended above the ground, a rope must go from pole 1 to 3 through pole 5, then the centre feed line can either be wrapped around or suspended from this rope. As well, a rope has to go from pole 3 to pole 4 to finish off the square.

APPENDIX B. List of materials and approximate prices.

Quantity	Description	Price/Unit
Existing Materials		
1	Net 75 ft.^{2}	
4	1 1/2 in. x 10 ft. poles(O.D. of pipe)	
1	1 1/2 in. x 14 ft. pole (O.D. of pipe)	
5	Hand crank boat winches	
5	20 - 25 ft. of 3/8 in. draw ropes for the winches	
4	side mount pulleys	
1	top mount pulley	
5	3 ft. x 1/2 in. rebar	
8	3 ft. metal fence posts	
8	Approx. 20 ft. of metal support cables	
Need for Conversion		
5	Helicopter cargo hooks	Approx. $2500
5	HDMSS (Part No. SS-42) (price does not include bracket)	30
	Any combination of the above two to make 5 hooks	
(5	HDMSS mounting brackets and ring holding pin assemblies)	**Materials & Labour**
11	1 1/2 in. muffler clamps	$1.00
16	Quick links (3/8 in.)	2.00
8	7-link pieces of chain (5 ft.)*	0.95/ft.
8	1/4 in. x 2 1/2 in. belt, nut & washers*	1.20
5	3/8 in. release ropes - 15 ft.	0.32/ft.
4	4 in. metal rings (for release ropes of cargo hooks)	3.00
1	2 in. metal ring (for release rope of HDMSS)	1.50
10	Snap hooks (for release and draw ropes)	2.00
1	Side mount pulley	5.00
2	12 V automotive batteries	60.00 - 100.00
1	12 V automotive starting solenoid (AMSS)	12.00
1	12 V relay switch	4.00
1	Push button release switch	8.50
1	Waterproof container for batteries, AMSS and relay switch (e.g. cooler or plywood box)	?
5	Waterproof containers for hooks and insulation (e.g. garbage bags and scrap fibreglass or rags)	?
4	Battery terminal clamps	1.50
2	Rolls of black electricians tape	0.70

5	4-wire automotive trailer plugs	3.50
2	75-m spool, 14 gauge CABTIRE elec. wire**	89.00
1 or 2	300-m spool, 24 gauge blasting wire	20.00
5 pk.	Blue insulated wire crimps	1.50
1 pk.	Yellow insulated wire crimps	1.50
1 pk.	Yellow circle (3/8 in. hole) wire crimps	1.50
1 pk.	Blue fork wire crimps	1.50
1 pk.	Red fork wire crimps	1.50
1 pk.	Red female wire crimps	1.50
2	No. 2 wire connectors	0.80

* If using 5 HDMSS, these are not needed.
** Price quoted is for 3-strand cabtire, which is cheaper than 2-strand.

Wildlife Working Reports should not be cited because of the preliminary nature of the data they contain

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